## Lead

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Lead (IPA: /IEd/) is a chemical element in the periodic table that has the symbol Pb (Latin: plumbum) and atomic number 82. A soft, heavy, toxic and malleable poor metal, lead is bluish white when freshly cut but tarnishes to dull gray when exposed to air. Lead is used in building construction, lead-acid batteries, bullets and shot, and is part of solder, pewter, and fusible alloys. Lead has the highest atomic number of all stable elements - although the next element, bismuth, has a half life so long (longer than the estimated age of the universe) it can be considered stable. Like mercury, another heavy metal, lead is a potent neurotoxin which accumulates in soft tissues and bone over time.

## **Contents**

- 1 Notable characteristics
- 2 History
- 3 Occurrence
  - 3.1 Lead mining in .
     Wales
  - 3.2 Processing of metal from ore
  - 3.3 Production and Recycling
- 4 Isotopes
- 5 Health effects
  - 5.1
     Biochemistry
     of lead
     poisoning
- 6 Descriptive.

|                        |  |          |                                  | *****   |                                       |      |       |  |  |  |  |  |
|------------------------|--|----------|----------------------------------|---|---------------------------------------|------|-------|--|--|--|--|--|
| 82                     | thallium $\leftarrow$ lead $\rightarrow$ bismuth |          |                                  |   |                                       |      |       |  |  |  |  |  |
|                        | Pb. 82P<br>125N<br>Periodic Table                |          |                                  |   |                                       |      |       |  |  |  |  |  |
| General                |  |          |                                  |   |                                       |      |       |  |  |  |  |  |
| Name, Symbol, Number   |  |          |                                  | lead, Pb, 82  |                                       |      |       |  |  |  |  |  |
| Chemical se            | Chemical series                                  |          |                                  |   | Post-transition metals or poor metals |      |       |  |  |  |  |  |
| Group, Perio           | od, Blo  | k        | 14, 6, p                         |   |                                       |      |       |  |  |  |  |  |
| Appearance             |  |          |                                  | bluish gray   |                                       |      |       |  |  |  |  |  |
| Standard atomic weight |  |          |                                  | 207.2(1) g·mol <sup>-1</sup>                        |                                       |      |       |  |  |  |  |  |
| Electron con           | ifigurat   | ion      | [Xe] $4f^{14} 5d^{10} 6s^2 6p^2$ |   |                                       |      |       |  |  |  |  |  |
| Electrons pe           | r shell  | 2, 18, 4 | •••                              |   |                                       |      |       |  |  |  |  |  |
| Physical properties    |  |          |                                  |   |                                       |      |       |  |  |  |  |  |
| Phase                  |  |          |                                  | solid   |                                       |      |       |  |  |  |  |  |
| Density (near r.t.)    |  |          |                                  | 11.34 g·cm <sup>-3</sup>                            |                                       |      |       |  |  |  |  |  |
| Liquid density at m.p. |  |          |                                  | 10.66 g·cm <sup>-3</sup>                            |                                       |      |       |  |  |  |  |  |
| Melting point          |  |          |                                  | 600.61 K<br>(327.46 °C, 621.43 °F)                  |                                       |      |       |  |  |  |  |  |
| Boiling point          |  |          |                                  | 2022 K<br>(1749 °C, 3180 °F)                        |                                       |      |       |  |  |  |  |  |
| Heat of fusion         |  |          |                                  | 4.77 kJ·mol <sup>-1</sup>                           |                                       |      |       |  |  |  |  |  |
| Heat of vaporization   |  |          |                                  | 179.5 kJ·mol <sup>-1</sup>                          |                                       |      |       |  |  |  |  |  |
| Heat capacity          |  |          |                                  | (25 °C) 26.650 J·mol <sup>-1</sup> ·K <sup>-1</sup> |                                       |      |       |  |  |  |  |  |
| Vapor pressure         |  |          |                                  |   |                                       |      |       |  |  |  |  |  |
| P(Pa)                  | · · · · · · · · · · · · · · · · · · ·            |          | Ī                                | 100   | 1 k                                   | 10 k | 100 k |  |  |  |  |  |
| at T(K)                | 978  | 1088     |                                  | 1229  | 1412                                  | 1660 | 2027  |  |  |  |  |  |
| ,                      | Atomic properties                                |          |                                  |   |                                       |      |       |  |  |  |  |  |
| Crystal structure      |  |          |                                  | cubic face centered                                 |                                       |      |       |  |  |  |  |  |
| Oxidation states       |  |          |                                  | 4, 2<br>(Amphoteric oxide)                          |                                       |      |       |  |  |  |  |  |
| Electronegativity      |  |          |                                  | 2.33 (scale Pauling)                                |                                       |      |       |  |  |  |  |  |
| Ionization energies    |  |          |                                  | 1st: 715.6 kJ·mol <sup>-1</sup>                     |                                       |      |       |  |  |  |  |  |

- chemistry

  7 Applications
  - 7.1 Former applications
- 8 Phrases
- 9 See also
- = 10 Literature
- 11 References
- 12 External links

## Notable characteristics

Lead has a dull luster and is a dense, ductile, very soft, highly malleable, bluishwhite metal that has poor electrical conductivity. This true metal is highly resistant to corrosion. Because of this property, it is used to contain corrosive liquids (e.g. sulfuric acid). Lead can be toughened by adding a small amount of antimony or other metals to it. Lead is the only metal in which there is zero Thomson effect. Lead is also poisonous. All lead, except <sup>204</sup>Pb, is the end product of a complex radioactive decay (see isotopes of lead below).

## History

Lead has been commonly used for thousands of years because it is widespread, easy to extract and easy to work with. It is highly malleable and ductile as well as easy to smelt. In the early Bronze Age lead was used with antimony and arsenic. Lead was mentioned in the Book of Exodus (15:10). Alchemists thought that lead was the oldest metal and associated it with the planet Saturn. Lead pipes that bear the insignia of Roman emperors

| (more)                    |             |                                | 2nd:  | 1450.5                         | kJ·mol <sup>-1</sup>                |                   |  |  |  |  |
|---------------------------|-------------|--------------------------------|---|--------------------------------|-------------------------------------|-------------------|--|--|--|--|
|                           |             |                                | 3rd:  | d: 3081.5 kJ·mol <sup>-1</sup> |                                     |                   |  |  |  |  |
| Atomic radius             |             |                                | 180   | pm                             | ·                                   |                   |  |  |  |  |
| Atomic radius (calc.)     |             |                                | 154   | pm                             |                                     |                   |  |  |  |  |
| Covalent radius           |             |                                | 147   | þm                             |                                     |                   |  |  |  |  |
| Van der                   | Waals re    | dius                           | 202 pi                                      | n.                             |                                     |                   |  |  |  |  |
| Miscellaneous             |             |                                |   |                                |                                     |                   |  |  |  |  |
| Magneti                   | c orderin   | g                              | diamagnetic                                 |                                |                                     |                   |  |  |  |  |
| Electric                  | al resistiv | rity                           | (20 °C) 208 n u·m                           |                                |                                     |                   |  |  |  |  |
| Thermal                   | conduct     | ivity                          | (300  | K) 35.3                        | W·m <sup>-1</sup> ·K <sup>-1</sup>  | ,                 |  |  |  |  |
| Thermal expansion         |             |                                | (25 °                                       | °C) 28.9                       | μm·m <sup>-1</sup> ·K <sup>-1</sup> |                   |  |  |  |  |
| Speed of sound (thin rod) |             |                                | (r.t.) (annealed)<br>1190 m·s <sup>-1</sup> |                                |                                     |                   |  |  |  |  |
| Young's modulus           |             |                                | 16 (  | 3Pa                            |                                     |                   |  |  |  |  |
| Shear modulus             |             |                                | 5.6 GPa                                     |                                |                                     |                   |  |  |  |  |
| Bulk modulus              |             |                                | 46 GPa                                      |                                |                                     |                   |  |  |  |  |
| Poisson ratio             |             |                                | 0.44  |                                |                                     |                   |  |  |  |  |
| Mohs hardness             |             |                                | 1.5   |                                |                                     |                   |  |  |  |  |
| Brinell hardness          |             |                                | 38.3 MPa                                    |                                |                                     |                   |  |  |  |  |
| CAS reg                   | gistry nu   | nber                           | 7439-92-1                                   |                                |                                     |                   |  |  |  |  |
| Selected isotopes         |             |                                |   |                                |                                     |                   |  |  |  |  |
|                           | ·           | Main art                       | ticle: I                                    | sotopes of                     | lead                                |                   |  |  |  |  |
| oai                       | NA          | balf-life                      |   | DM                             | DE (MeV)                            | DP                |  |  |  |  |
| <sup>204</sup> Pb         | 1.4%        | >1.4×10 <sup>17</sup> y        |   | Alpha                          | 2.186                               | <sup>200</sup> Hg |  |  |  |  |
| <sup>205</sup> Pb         | syn         | 1.53×10 <sup>7</sup> y         |   | Epsilon                        | 0.051                               | 205 <sub>T1</sub> |  |  |  |  |
| <sup>206</sup> Pb         | 24.1%       | Pb is stable with 124 neutrons |   |                                |                                     |                   |  |  |  |  |
| <sup>207</sup> Pb         | 22.1%       | Pb is stable with 125 neutrons |   |                                |                                     |                   |  |  |  |  |
| <sup>208</sup> Pb         | 52.4%       | Pb is sta                      | ble wi                                      | ith 126 neutrons               |                                     |                   |  |  |  |  |
| 210 <sub>Pb</sub>         | trace       | 22,3 y                         |   | Alpha                          | 3.792                               | <sup>206</sup> Hg |  |  |  |  |
| Pb                        |             | <sup>22,3</sup> y              |   | Beta                           | 0.064                               | <sup>210</sup> Bi |  |  |  |  |
| References                |             |                                |   |                                |                                     |                   |  |  |  |  |

